Modeling of the scattering polarization of strong resonance lines: forward and inversion problems

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The measurement of the magnetic field in the chromosphere and transition region remains a formidable challenge. Frontier research in this field combines the diagnostic potential of the Zeeman and Hanle effects in strong resonance lines. The practical application of this diagnostic approach has been hampered by the complexity of its modeling, which must account for non-LTE effects, scattering polarization, PRD, and the impact of bulk velocities. Here, we expose an efficient solution strategy for this radiative transfer problem, presenting results in 1D atmospheric models for different spectral lines of interest for chromospheric magnetic field diagnostics, such as Ca I 4227, Mg II h&k, H I Ly-α, and He II 304. We also expose preliminary forward modeling calculations carried out in 3D atmospheric models extracted from state-of-the-art R-MHD simulations of the solar atmosphere. Furthermore, we leverage our efficient solution strategy to tackle the inversion problem, presenting the successful retrieval of height-dependent magnetic and bulk velocity fields in 1D models by inverting synthetic scattering polarization signals of Ca I 4227.